A STUDY ON EXCLUSION OF VARIABLES DURING ADOLESCENCE

DISSERTATION

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Her work is genuine and original.

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CHAPTER I

THE PROBLEM & ITS SETTING

Unit Two I

The Universe and It's Setting

Introduction

Science and its related technology are inextricably woven into the fabric of modern society. This intimacy and everyday encounter, is responsible for many problems that face citizens, who may have been exposed to science teaching but have not been educated in Science. They do not understand what scientists are trying to do and how they do it and they are not prepared to evaluate the aims and aspirations of scientists. This understanding comes from simple scientific investigations, in the course of which the tactics and strategies of scientists become familiar. As to meet the demands of a science and technology oriented society the focus of science education from school level to college should be on the development of the ability to think

critically and imaginatively. Science, as both dynamic process and rapidly changing product, is of value in education because it promotes an understanding of its own structure, values and processes. The report of the Educational Policies Commission on Education and the Spirit of Science (N.E.A., U.S.A., 1966) says :

> "In the modern world the approach of rational inquiry the mode of thought which underlies science and technology is spreading rapidly and, in the process, is changing the world in profound ways.... The spirit of rational inquiry, driven by a belief in its efficacy and by restless curiosity, is.... commonly called the spirit of Science."

Students who learn how scientists learn simultaneously learn what science is. Instead of visualizing science as a corpus of unchanging facts and theories to be memorized, students should see the dynamic processes of scientific investigation. Students may isolate problems, invent working hypotheses, and derive from data the simplest principles or laws.

It is important to know many scientific facts and principles. It is reasonable to expect that the more the individual knows, the greater the probability that he will see the relationships between the principles and concepts of Science and thereby facilitate personal integration of Science. These are important goals as fostering the growth

of the science and its effect on daily life. Science is important in everyone's life and whether he knows it or is directly effected. According to W.J. Jacobson : "Science is the investigation and interpretation of events in the natural, physical environment and within our bodies. Probably man has always wondered about the world. Certainly, children continue to ask questions, to seek answers, and to make sense out of the blooming, buzzing confusion, of the world into which they are born. Science is perhaps our most important approach to understanding. It is of special importance that our children become aware of how we strive for understanding and the nature of the conceptual structures that have been built through Science.

Through the use of the methods and processes of Science, we have developed conceptual schemes that help us organize our knowledge of the world in which we live. The weights of various chemical elements were merely a set of numbers until Mendeleev and others arranged them in order and noticed that in their list various physical properties recurred periodically. Mendeleev built a periodic table of the elements. This periodic table was such a powerful conceptual properties of chemical elements that had not yet been discovered.

What should children gain from a study of science.

he answer with four goals :

1. The building of a world view that is in conformance with the view of our world and our universe now being developed in the Sciences;

2. The fostering of an understanding of the conceptual structure of Science;

3. The development of skill in using some of the key processes of Science, and lastly

4. The encouragement of an informed application of man, and of how science affects modern man and his society."

J.D. Bernal says : "Science may be taken as an institution, as a method, as a cumulative tradition of knowledge, as a major factor in the maintenance and development of production and as one of the most powerful influences moulding beliefs and attitudes of the universe and man. This does not mean that there are as many different sciences. Science has so changed its nature over the whole range of human history and no definition could be made to fit.

More than any other human occupations Science is, by its nature, changeable. It is also, as one of the latest achievements of humanity, changing most rapidly. Nor has it long had a separate existence. At the dawn of civilization, it was only one aspect of the work of the magician, the cook or the smith. It was not until the seventeenth century that it began to achieve an independent

status; and that independence may itself be only a temporary phase. In the future, it may well be that scientific knowledge and method will so pervade all social life that Science will once again have no distinct existence."

According to Cedric Griggs, "In the literal sense, Science means the pursuit of knowledge but it has a wider connotation for our purpose, and can be said to mean a knowledge of nature in the widest possible form. This includes nature study physics, astronomy, meteorology and much more. It is equally important to look beyond, mere precise definition and see what Science includes, and the following are of fundamental importance to the approach to his subject :

1. Direct and indirect observations.
2. Scientific inquiry - asking questioning.
3. The drawing of inference from evidence.
4. Recording observations.
5. Developing ways and means to find answers.
6. Classification and checking evidence.

Science in fact is more than a subject, it is a method of acquiring knowledge and of necessity the approach must be correct."

Although many people live their lives without direct contact with Science, few escape the technology that comes from Science. To avoid a knowledge of Science is to give up the right to make knowledgeable decisions about

Science and therefore about one's life in a society that is deeply affected by Science. Policy statement in Science Education (1961, of Europe says :

> "The effect of Science on human life and thought have become so great and are potentially so much greater that those who have no understanding of them and of the Science which has produced them, cannot be properly considered educated or truly cultured and are therefore unable to participate in the life of their time. Perhaps scientific illiteracy is in part due to the lack of factual knowledge, but is much more the result of a lack of understanding of the basic nature and aims of Science....
> Science should be recognized and taught as a major human activity which explores the realms of human experience, maps it methodically but also imaginatively and by disciplined speculation creates a coherent system of knowledge."

While analysing several definitions of Science, M. Vaidya described : "Science as a Great human enterprise not only endless and faceless but also stable and fluid - self accumulating, self growing and self accelerating. It attempts to provide an objective body of knowledge through objective as well as subjective procedures.... It thus wheels on dogmatism, dynamism and discovery at the same time. It is more than puzzle solving etc."

He further says that "when seen in a limited context, it is through a series of adjustment and readjust-

ments of hypotheses that the new concept or skill carried out in the most real like manner that a new concept or skill like a baby is born."

"This struggle is intense when a new concept and skill or technique try to find a place in the well established body of knowledge and scientific methodology."

Professor Irwin Bleenick says : "The world we live in is a marvel of man's mastery over his environment. Through the explosive development of the natural sciences we now predict, control and understand phenomena to an extent never fully envisioned, throughout the millions of years of human development prior to the current century. The scientific revolution has maximized opportunities for human happiness, and through its technical arms; in providing material wealth and long and healthy lives. New knowledge and the process by which it is obtained, promise a spiritual fulfilment unavailable from the dry bones of fatalism and mysticism.

Fundamental to the conquest of nature by the scientist has been his method of approach to the unknown. Facts and understandings bring the scientist to the frontier, but it is scientific methodology that extends the frontier of knowledge.

For the student of science - for the citizen who must live in harmony with the times and participate

constructively in a scientifically impacted society - information alone does not create literacy. The individual must learn through personalized experience the manner in which new knowledge is won from its natural ore."

Hence the school education should try to realize the great opportunities which the development of Science has made apparent in the world. They can do this by promoting understanding of the values on which Science is everywhere based. Although no particular scientists may fully exemplify all these values, they characterize the enterprise of Science, as a whole.

1. Longing to know and to understand.
2. Questioning of all things.
3. Search for data and their meaning.
4. Demand for verification.
5. Respect for logic.
6. Consideration of premises.
7. Consideration of consequences.

These values are part and parcel of any true education. These are characteristic not only of what is commonly called Science, but more basically, of rational thought and that applies not only in Science, but in every area of life. What is being advocated here is not the production of more physicists, biologists or mathematicians, but rather the development of persons whose approach to

life as a whole is that of a person who thinks.... a rational person.

Successful science teaching in the school education demands of the teacher an understanding of how children think and particularly of how they think in science.

Dr. A.B. Joshi says : "A good Science teacher is there not merely to provide answers and explanations, but to stimulate students to raise questions and find answers. The choice is between two alternatives, that is, whether to lose time or to gain it. If deeper consideration is given to the essence of teaching science scientifically, there appears to be no contradiction in terms for as the saying goes, a stitch in time saves nine. Children are educated out early in the business of acquiring knowledge and skills comparatively at a much lower age than hitherto considered for they learn to make observations, analyse them and even interpret them. The basic problem after all is reduced to 'how to take half an hour to teach what you could tell in one minute.' It is an earning answer to the question which lays the foundation for the scientific attitude."

Children's logic is somewhat different from that of adults, but in many significant ways it is surprisingly similiar. The older psychologists of child learning held that children were not able to think abstractly, to reason

logically and causally, to apply conceptual learning to new situations or in other words children were condemned to learning without thinking. The research of Jean Piaget and his co-workers has proved that these ideas are incorrect. Children can think on high levels if they have sufficient concrete experience and guidance to enable them to develop the necessary concepts and relationships.

Children's thinking resembles that of scientists in many ways, although not of course at the same level of sophistication. To think in causal terms, children seek answers to these questions. Because an important goal of school education is to help children to think more clearly and more effectively, the teachers need to operate with a higher level of knowledge about children's thought processes.

Concerning the growth of logical thinking among children, Piaget has given a stage concept according to which intelligence of children develops in stages, with clear definable steps. He has shown that all children's thinking develops not only within a given stage but also how the thinking at a lower stage changes into the thinking at a higher stage as the children go up the school ladder. According to him formation of hypotheses comes naturally to the adolescence pupils especially after the age of eleven. This is so Piaget believes, and has also demonstrated on it by carrying out thought provoking experiments on children from 36 hours old to about 16+, for about forty years.

possibilities rather than realities dominate thinking at this stage called the formal stage. During this stage the adolescent pupils acquire the basic elements of scientific methods. J.A. Lauwerys has also stressed that this type of thinking enters into all subjects when presented problematically. The present study was undertaken in order to test part of Piaget's ideas on formal stage.

DEFINITIONS AND TYPES OF THINKING

In general the term thinking has been referred to as "abstracting, analysing, comparing, conceiving, deducing, defining, estimating, generalizing, guessing, imagining, judging, knowing, opining, reasoning, recalling, recognizing, reflecting, remembering, searching for conclusions and understanding." In restricted psychological sense, it may refer to "determined course of ideas, feeling, formulation and assertion of propositions, percepts and vocal sound."

Symmonds has listed nineteen types of thinking such as learning, meaning, stating relationships, defining etc.

Burt and his students, have regarded it a "hierarchy of thinking abilities comprising of relation, association, perception and sensation" etc.

In the words of Hearnshaw in recent studies in the Psychology of Thinking :

"Thinking-highly organized and balanced activity dependent upon the co-ordination of a large number of subordinate activities under favourable conditions is inseparably linked with the personality traits of its thinker. This complex activity is difficult to investigate if it remains ghost like but, on the other hand, if it is regarded as a skill (or a group of skills) which is organization, "a viewpoint quite in conformity with Piaget's genetic findings, with the evidence pointing to the motor accompaniments of thought and the results of perceptual studies emphasizing the dynamic nature of perception and the acquired character of all but the simplest perceptual structures"; then it is possible to investigate thinking by trying to bear upon the psychology of thinking all that the psychologist has learned about learning keeping in mind that skills are essentially activities and skills are learned and their basic feature is organization."

John Dewey regarded thinking as a function of an "obstacle in the way of goal directed activity." To quote Dewey :

"Sensory qualities experienced through vision have their cognitive status and office, not (as sensational empericism, holds) in and out of themselves in isolation, or as merely forced upon attention, but because they are the consequences of definite and intentionally performed operations. Only in connection with the intent, or idea,

of these operations do they amount to anything, either as disclosing any fact or giving test and proof any theory. The rationalist school was right in so far as it insisted that sensory qualities are significant for knowledge only when connected by means of ideas. But they were wrong in locating the connecting ideas in intellect apart from experience. Connection is instituted through operations which define idea and operations are as much matters of experience as are sensory qualities."

Dewey has been further followed by many practical workers in the field. Among them few to mention are : Burt (1926); Johnson (1944); Polya (1945); Humphrey (1946); Bloom (1950); Burrack (1950); Hoffman and his co-workers (1951); Vinacke (1952); J.Stanley Gray (1956); Mill and Dean (1960); Vad and Vaidya (1975).

With special reference to school subjects, Peel distinguished four different kinds of thinking, namely Thematic, Explanatory, Productive and Integrative.

Thematic Thinking : This thinking is fairly free. The pupils can speculate freely as he is not supposed to solve any practical problems or his solution must meet certain practical criteria. Such thinking is consistent with the theme of the essay, painting or piece of music. It has also to communicate. Since it is described in terms of content or product, it is called Thematic Thinking.

Explanatory Thinking : This thinking is more controlled than thematic thinking. The direction of thought has to conform to a practical criterion of explaining events. All school subjects require explanatory thinking i.e. describing and explaining events and things. Explanatory thought provides the potentiality or jumping off point for real control over and manipulation of environment. The control of the associations by practical criteria, the testing of hypotheses against the facts, the acceptance of some event or theory as being reasonably probable and the formation of language that deals with concepts and classes of objects are some of its distinguishing characteristics. This kind of thinking is common to most of us and is a major topic for all writers and research workers upon thought processes.

Productive Thinking : When the attack on a problem is taken beyond the stage of explanation and used to modify the situation so that the original problem is removed, the subject is, thinking in a productive way. Like Explanatory thinking, it enters into every school subject. It often enters into practical science experiments as when the pupil is asked to arrange a set of pulleys or levers to obtain a given mechanical advantage or to arrange a concave mirror and small light so that he can see down a person's throat. The main features of productive thinking are that it starts from explanatory thought but that

(a) it contains an element of forward thinking.

(b) it becomes effective by changing the problem situation materially in order to achieve solution.

(c) some new problems may be solved by restating them in the light of established explanation.

(d) it always appears when a new problem situation is met.

(e) these situations may be material, social or personal.

Integrative Thinking : Integrative thought concerns the fundamentals time, Space, Matter, Causality, Beauty, Goodness, Truth, Life, and the like. The child and adolescent ask questions and theorise about these ultimates.

Integrative thinking is in the first place hypothetico-observational in that it proceeds by observation and experimentation but also in that the thinker knows to some extent what he is looking for.

Secondly, integrative thinking is analytico-disjunctive. Although the experimenter knows what he is looking for, this knowledge may arise from alternative hypotheses, and the experimenter examines this or that hypothesis on the basis of the material available. He may feel a certain hypotheses is right, but he must properly eliminate alternatives.

Thirdly, the integrative thinker proceeds from a challenge to 'common sense', and his new hypothesis is at once more synthesizing and more sensitive. At this stage the thinking is often deductive.

It is the highest form of thinking which appears among highly creative individuals. They try to link various fields in natural and social sciences. Their work has implications for the succeeding workers. Examples are : Socrates, Plato, Aristotle, Darwin, A.N. Whitehead, A. Einstein, B.Russell, J.L. Nehru and Tagore.

Integrative thinking is present among very few persons whereas Thematic, Explanatory and Productive thinking are quite sufficient for the majority of school children.

PIAGET's STAGES OF INTELLECTUAL DEVELOPMENT

Jean Piaget and his co-workers have contributed most elaborate theory of intellectual development. Piaget's work has extended over about fifty years in various branches of knowledge. According to Piaget Intellectual functioning in its dynamic aspect is characterised by the invariant processes of assimilation and accommodation. An act of intelligence in which assimilation and accommodation are in balance or equilibrium constitutes an intellectual adaptation. Adaptation and organization are two sides of the same coin. Since adaptation presupposes an underlying

coherence, on the one hand, and organizations are created through adaptations, on the other hand.

Assimilation and accommodation constitute the most fundamental ingredients of intellectual functioning. Both functions are present in every intellectual act of whatever type and developmental level.

Piaget has stated 4 main stages (periods) of intellectual development with distinguishing characteristics:

1. Sensory Motor Period - birth to 2 years.
2. Pre-operational Period - 2 to 7 years.
3. Concrete operations Period - 7 to 11 years.
4. Formal operations Period - 11 to 15 years onwards.

Characteristics :

1. Sensory Motor Period : The first period of intellectual development is the Sensory motor period. In the first half of this period, the child's activity is centered on his own body. In the second half, the child develops schemes of practical intelligence that enable him to deal with objects in space. Child lives in his own practical world and he explores various possibilities, for his activities. Mainly performs the overt behaviour and lacks language.

2. Preoperational Period : Piaget calls this period as period of representational intelligence because the child is able to represent reality as language and mental

imagery. His thinking is governed by the perceptual considerations of the situations. He makes the judgement as he sees the situation but unable to resolve conflicting statements.

3. Concrete Operations Period : At the third stage the child is able to engage in activities of the mind which Piaget calls operations. These operations are actions on objects that can be carried out mentally without being carried out physically. The subject is tied to the concrete situation or the empirical data. He criticizes data and brings extraneous considerations into the problem situation. He understands the content of the problem but fails to appreciate the form of the argument. These operations are also reversible in the sense that they can be followed by another mental act which restores objects to their original states.

4. Formal Operations Period : During this period, the adolescent acquires the adult capacity for abstract thought. In the previous period the child is only beginning to extend his thought from the actual to the potential. The adolescent, theorizes about and criticizes the present operation of the world because he conceives of many possible, ways in which it could operate and many alternative ways in which it could be better. Here possibility dominates and reality becomes secondary. Combinativity, reversibility, associativity and identity, etc., available at the concrete

stage are shown to be generalized at the formal stage. This explains the emergence of operational schemata like combinational, proportional, mechanical, equilibria, correlations and probabilities.

DEFINITIONS OF HYPOTHESIS

Hypotheses are tentative ideas, tentative stabs, floating ideas, untested explanation, tentative assumption, shrewed guesses, generalization, hunch, imaginative idea, mental tool or model and temporary bridges etc.

According to Walter A. Thurber : "Hypothesis is defined as an explanation that has not been tested. Recently the word 'MODEL' has come into favour."

Popular Science Encyclopaedia of Science says : "Hypothesis, an unproved theory, a supposition that is put forward to explain certain observed facts. A hypothesis provides the basis for further examination and investigation. A hypothesis is the first generalization to be made in a scientific procedure. It may be proposed to explain existing data or it may be propounded as a guide in collecting data. It is supported by data in which no significant gaps appear it becomes a 'THEORY'. If it is proved to the extent that no other explanation can be developed that could explain the same data, the generalization becomes a 'LAW' of Science".

Norman R. Campbell defines : "An hypothesis is, strictly speaking, a proposition which is put forward for consideration, and concerning the truth or falsity of which nothing is attested until the consideration is completed. It is thus necessarily associated with doubt, but with doubt of a negative rather than a positive kind. with the doubt which consists of a suspense of judgement rather than with the doubt which consists of an inclination to disbelieve."

Carter V. Good and D.E. Scates say : "Hypothesis is a shrewed guess or information that is formulated and previously adopted to explain the observed facts and conditions and to guide in future investigations."

James Clark Maxwell defines : "The first process therefore in the effectual study of Science must be one of simplification and reduction of results of previous investigation to a form in which the mind can grasp them. The results of this simplification may take the form of a purely mathematical formula or of a physical hypothesis."

According to George A. Lundberg : "Hypothesis is a tentative generalizations, the validity of which remains to be tested. In its most elementary stage the hypothesis may be any hunch, guess, imaginative idea, which becomes the basis for action or investigation."

Based on these definitions it can be concluded that

"The hypotheses are Trial Ideas or ideas of doubtful reliability and validity which when put to test either clarify themselves (and) or clarify the problematic situation providing in the process, some objective knowledge (and) or skill of the open variety regardless of their manner of origination.

FUNCTIONS OF HYPOTHESES

1. They suggest new observations, experimentation and consequently provide directions to investigation under hand.

2. They provide ways out of the complex situations and if successful, make available new insights, concepts, and skills hither to unknown. These products of hypotheses always remain to question.

3. They detect strengths and weaknesses in argumentation, exploration and experimentation especially when conflicting results appear.

4. They provide further basis for investigation.

5. They help in selecting pertinent facts, concepts, and techniques or suggest the type of evidence needed to answer the basic problem.

6. They facilitate the emergence of insights and the highly varied acts of creation.

CHARACTERISTICS OF HYPOTHESES

1. They should be worded unambiguously.

2. They should be simple and sharp, so that they become testable. An hypothesis becomes of

little value if it can not be tested at all. Indirect evidence is then sought for.

3. They should be conceptually clear.

4. They should be related to the available techniques or firmly established body of knowledge or to the phenomenon under study.

5. They are neither right nor wrong at the time they are set up. They have therefore to undergo emperical testing.

6. They are either general specific, predictive inhering chance concepts.

7. Out of many competing hypotheses the most powerful one is the one which makes about half of the remaining hypotheses irrelevant on the first experiment. This cuts down the cost of experimentation. Necessarily, they have to be plausible.

8. They must answer the problem or alter it so that the question is framed in an answerable manner. If they do, they then are subject to the laws of logic, a branch of mathematics. If again successful, they become powerful concepts which disturb as well as refine the established body of knowledge until they finally merge in it.

FORMULATION AND TESTING OF HYPOTHESES

Setting up and Testing of hypotheses come handy to the problem solvers. If there are no hypotheses to a particular problem particularly in experimental, it means

that the whole problematic situation is opaque to the investigator. He has then nothing else to do but to drop the problem. Hypotheses are therefore nothing but tentative stabs at the problem, powerful beacons which light up unknown paths, 'out stretched arms' to grasp the truth or suggested answers to the problem. Hypotheses are neither true nor false. They are either accepted, rejected or partially accepted. It was Galelio who, before going to the university, discovered that the time period of a simple pendulum depends solely on its length.

It is not exactly known how the hypotheses arise in the minds of individuals. It is still a dark continent. Creative thinkers set up and reject a number of hypotheses. This situation is analogous to trial and error learning. According to Munn hypotheses develops in four stages namely, preparation, incubation (conscious as well as unconscious activities), inspiration (sudden emergence of the idea) and verification or revision. Hypotheses originate both from theory and facts. They may originate at different levels of development as well as depend upon the imaginativeness of the investigator.

STATEMENT OF THE PROBLEM

This study has been attempted to determine the stating and testing abilities among certain groups of adolescent pupils. The problem was stated as :

"A STUDY ON EXCLUSION OF VARIABLES DURING ADOLESCENCE".

PURPOSES OF THE STUDY

This investigation was attempted for the following purposes :

1. To determine the relationship between the scores on intelligence and the scores on exclusion of variables.

2. To determine the relationship between age, grade and the scores on exclusion of variables.

3. To point out the main educational implications based upon the findings of the study.

HYPOTHESES

The following hypotheses were put forth for the study :

1. There is no significant differences on the mean scores of intelligence test and the scores on Exclusion of Variables between the top group and the bottom group.

2. There is no significant correlation between the grades and scores on stating hypotheses.

3. There is no significant correlation between the grades and scores on Testing hypotheses.

JUSTIFICATION OF THE STUDY

Jean Piaget has maintained that development is absolutely a continuous process which begins for all practical purposes from the very moment of the child's birth.

There is a mutual interaction between the organism and the environment. At the same time the intellectual structures or all concepts around the world are born. At the beginning of childhood, there is absence of thought. At the pre-operational stage, thinking is governed by the perceptual considerations of the situation. At the concrete stage, abstract ideas need to be presented very concretely. They may be allowed to study, experiment and even play with the experimental material. They may be allowed to examine freely as many relations as possible among various variables in a given learning situation. It is only then that the children will assimilate knowledge. At this stage the adolescent pupils reason hypotheses. And this age differ from culture to culture but the sequence of development remains the same.

The researcher felt the necessity to carry out the present study influenced by the basic notions of Jean Piaget as the Education for understanding and problem solving is becoming the chief goal of education anywhere in the world's educational system. This becomes the chief objective of Scientific Instruction at school also. If attempts are made to achieve this objective at school, then the mentioned goal leads to the concept of self education for any educational system.

CHAPTER II

REVIEW
OF
KANNADA LITERATURE

CHAPTER II

REVIEW OF RELATED LITERATURE

The researcher has gone through the following literatures which have proved helpful in defining, formulating and planning the present study. Very few studies have direct bearing on this study.

Jean Piaget and his co-workers have investigated a large number of problems in the growth of logical thinking over pupils ranging from 5-15 to 16 years in age. An experiment which demonstrate fourth stage of Piaget's intellectual development was reported by Inhelder and Piaget (1958) on the problems raised in the oscillation of a pendulum.

N.Vaidya (1968) carried an experimental study of Problem Solving in Science among certain group of Adolescent children. His problems were from physical sciences. His

findings indicate :

1. Though adolescent pupils are in a position to state hypotheses, most of them are not in a position to test them.

2. Adolescent pupils do not exhaust all possibilities.

3. A given problem is solved over a wide I.Q. range not only within a given age group but also across the various age groups.

E.A. Peel (1959) at Birmingham, carried out original work on children's thinking using Piaget's model with special reference to school education, he identified four kinds of thinking.

R.M. Misra (1973) investigated the role of hypotheses in problem solving among Grade X science students. His study indicated that :

1. There is no significant difference between the top group and the bottom group on the number of hypotheses emitted by them.

2. A given problem is solved over a wide I.Q. range. In other words, a low I.Q. pupil may solve the problem successfully whereas a high I.Q. pupil may fail on it.

3. Many adolescent pupils experience difficulty in testing hypotheses.

Margret Donaldson (1963) has carried out a study of Children's Thinking which was based on systematic research

of the type of error commonly made by children in attempting to solve problems. The children studied fall into the age group between 9 to 15 years and the problems used were verbal group intelligence tests. Her analysis of the results suggested a sorting of errors into three main groups, that is, first, to the work of Piaget; second to work by Goldstein and Luria; and third, to work by Broadvent and others on attention and immediate memory.

Mary Allen Quinn (1971) carried out study on Evaluation of a Method For Teaching Hypotheses Formation to 6th Grade Children. Her findings support the idea that children can be taught to generate ideas, to hypothesise. She has developed a hypothesis quality scale, based on a set of criteria drawn largely from the philosophy of Poincare, Popper, Hanson, Cowe and Black.

Avinash Grewal (1978), investigated the relationship between Hypotheses Testing Ability and Creativity. She developed a test containing problems having short answers from the areas of Physics, Chemistry and Biology in which the students were asked to give more than one way of solving a given problem. She also found the significant correlation between hypotheses testing ability and the creativity variables like fluency and originality.

Robert A. Mangel and Robert R. Bull (1972) on study 'Exclusion of Irrelevant Factors' investigated the growth in

the logical operations of exclusion on science students selected randomly from grades VII, IX and XII. The students were from the lower socio-economic status. They concluded that there is a gradual growth of the scheme of though between Grade 7 and Grade 12. They did not notice any sex differences.

Harrent T. Hollman and Anton E. Lawson (1978) have worked on a problem similar to the present study. Proportional Reasoning being their varinble. They have studied the Influence of Instruction on Proportional Reasoning in Seventh Graders. They concluded that the individualized procedures based on the use of physical materials are more effective than verbal text book procedures in teaching students to solve problems involving the formal scheme of proportionality.

Luis L. Cantu and J. Dudley Herren (1978) in an elaborate study on 'concrete and formal Piagetian stages and science concept Attainment' tried to investigate an instructional strategy for teaching concrete and formal science concepts based on the technique of concept analysis outlined by Markle and Tiemann (1971) and Klausmeier and his associates (1974), using the formats recommended by Herron (1977). The sample constituted 137 students with a median age 16.25 years. The sample was administered the longest test (1962, 1964) to classify students as concrete operational and formal operational. 12 concrete operational and 16 formal

operational students participated in the study. The students were instructed for a period of 6 weeks with one concept a week. The student studied a concept lesson for 12 minutes and afterwards took a 5-8 minute test. Instruction and Testing was done during a 20 minute activity period.

Their study showed that the concrete operational students were not able to learn concrete concepts i.e. concepts with perceptible examples and perceptible attributes as well as formal operational students. Formal operational students will learn formal concepts better than the concrete operation students. Both concrete and formal operational students are benefitted from the pseudo-examples.

PLAN AND PROCEDURE

CHAPTER III

PLAN AND PROCEDURE

SAMPLE AND SUBJECTS

Altogether 100 students of class VIII, class L, Class K and class AI of Demonstration Multi Purpose High School, Regional College of Education, Ajmer constituted the sample. 25 students from each class in the following age groups 12+ to 17+ were included.

The sample students consist of day scholars only of average socio-economic status, and belonging to urban areas. The ages of the pupils were taken from the official register of the school.

DELIMITATIONS OF THE STUDY

The investigation was delimited to the size of the sample (N = 100) drawn from only one school.

The age group of the sample was highly restricted, ranging from 12+ to 17+ years. The sample from same socio-economic status and belonging to urban areas only were selected. All the samples included were offering the general science as their compulsory subject.

SELECTION OF TOOLS

The following tools were used for collecting data :

1. Cattells' Culture - Fair Intelligence Test (Scale II) to determine the scores on intelligence.

2. Two reliable and valid instruments for measuring the variables :
   (i) Stating Hypothesis } Exclusion of
   (ii) Testing Hypothesis } variables
   i.e. Stating Hypothesis Questionnaire and Testing Hypothesis Questionnaire.

DESCRIPTION OF TOOLS

1. Cattells' Culture-Fair Intelligence Test :

This Culture Fair Intelligence Test (or Culture Free) aims to single out the most consistent core of basic mental capacity.

This test help in the separation of intelligence measurement from scholastic and general knowledge while maintaining a validity of basic intelligence measurement better than performance tests and at least as good as traditional pencil and paper tests.

Everywhere these perceptual tests, inspite of some strangeness and lack of 'face validity' as to their content, proved equal in validity to the traditional tests and superior in applicability to groups of varied racial and social background or students differing in areas of academic specialization.

There are 4 tests in this Culture Fair Intelligence Test. Test (1) Series, Test; Test (2) Classification; Test (3) Matrices; and Test (4) Conditions (Topology) with 12 items in 3 minutes, 14 items in 4 minutes, 12 items in 3 minutes and 8 items in 2½ minutes respectively.

(ii) Stating Hypothesis Questionnaire :

In this questionnaire four problems were given namely :

1. The dropping of pebbles after passing the heat through different rods - Rod Problem.

2. The drying up of handkerchief - Handkerchief Problem.

3. The flow of water through a narrow tube in a small beaker - beaker Problem

4. The oscillation of a simple pendulum - Pendulum Problem.

(See appendix for questionnaire)

(iii) Testing Hypothesis Questionnaire

In this questionnaire 11 hypotheses of four problems

were given. The different hypotheses on each problems were :

Problem 1 - Rod Problem :

(a) Thickness of the Rod.
(b) Length of the Rod.

Problem 2 - Handkerchief Problem :

1. Length of handkerchief.
2. Thickness of handkerchief, and
3. Nature of material.

Problem 3 - Beaker Problem :

1. Length of tube.
2. Size of hole.
3. Level of water in larger beaker

Problem 4 - Pendulum Problem :

1. Length of the pendulum
2. Volume of bob.
3. Weight of bob.

(see appendix for questionnaire)

ADMINISTRATION OF THE INTELLIGENCE TEST

The Intelligence Test was administered to the sample selected in their respective classes. The instructions and the directions were read by the investigator to the pupils. The time was given to the pupils as mentioned in the test manual.

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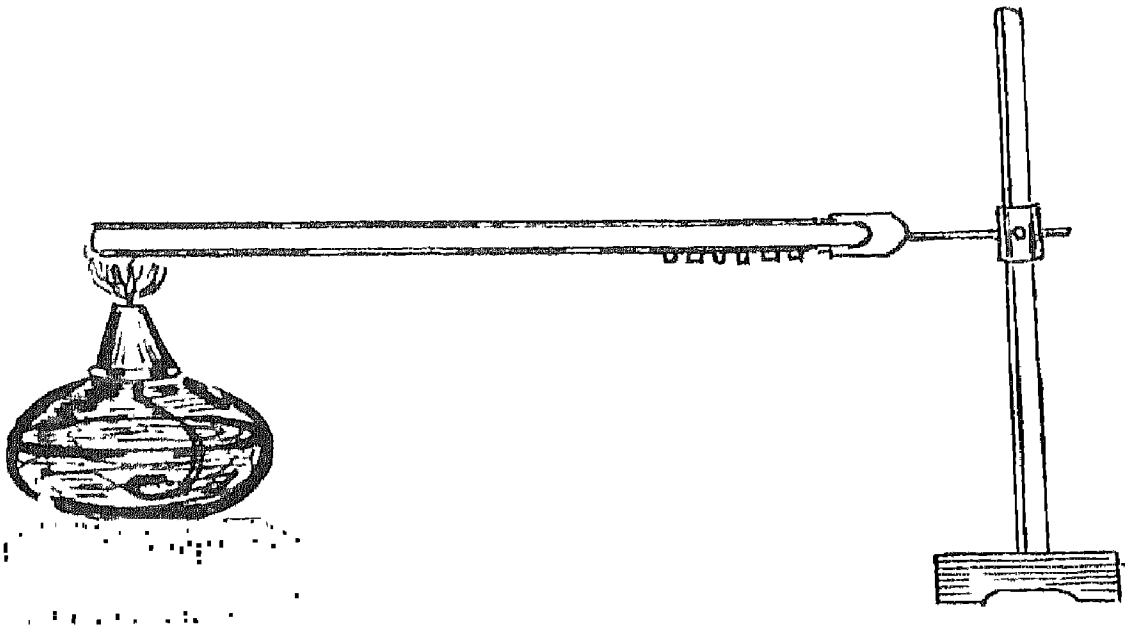
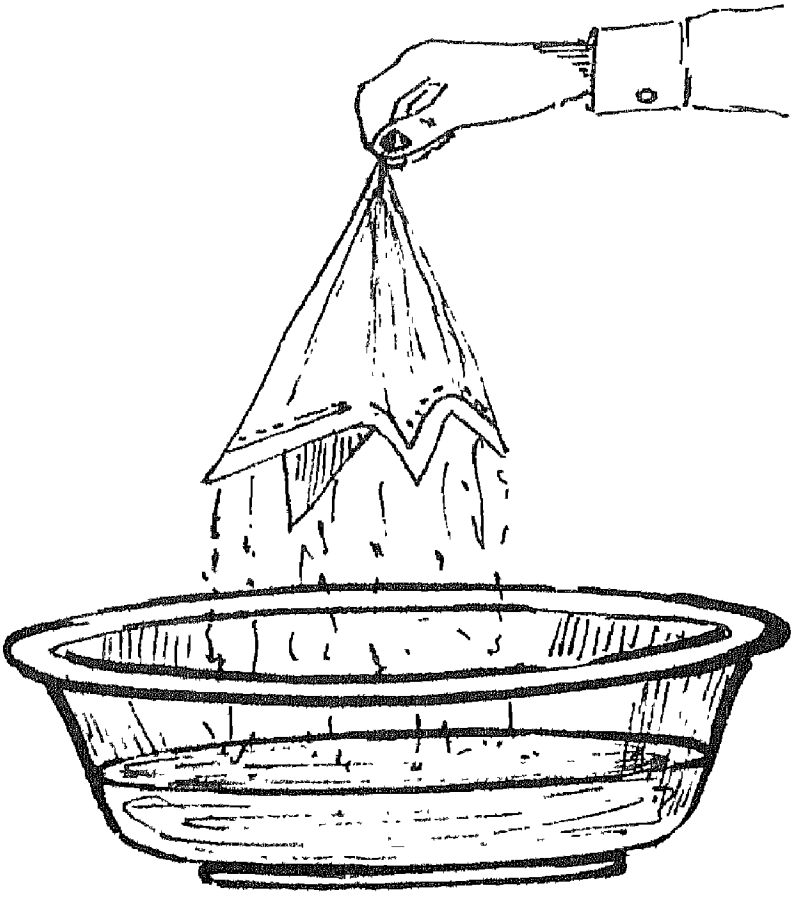
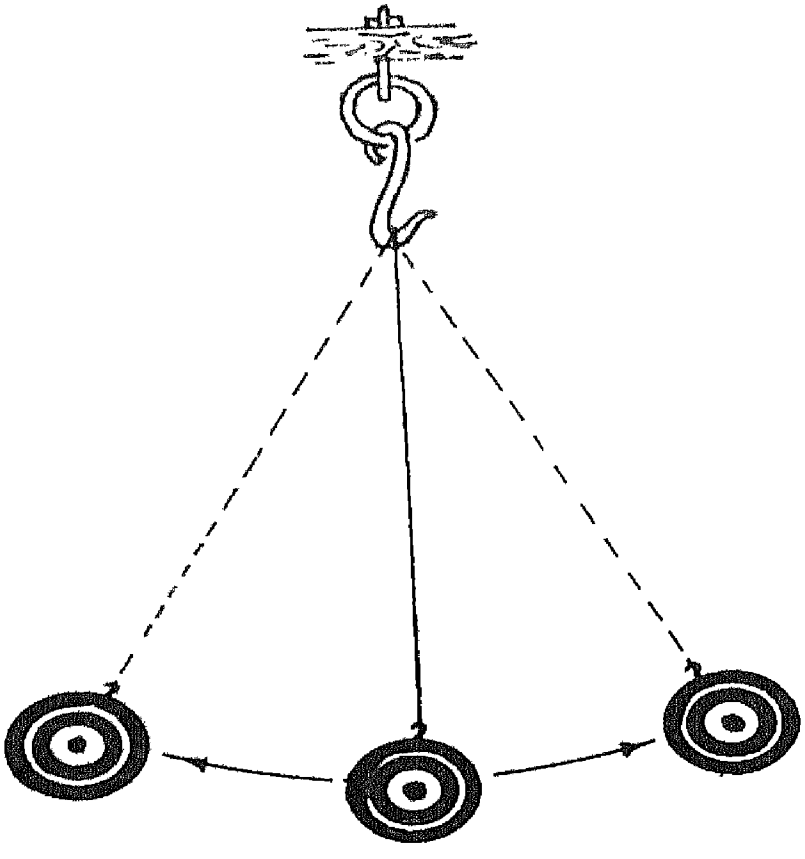


Problem 1



Problem 2

Problem 3



Problem 4

ADMINISTRATION OF STATING HYPOTHESIS QUESTIONNAIRE & TESTING HYPOTHESIS QUESTIONNAIRE

The administration was done to the sample selected in their respective classes. The experiments on different problems were set up. The questionnaire on stating hypothesis were distributed and the instructions were given. The subjects were asked to observe the experiments and write down the different hypotheses on the problems presented. The time taken to state the hypotheses ranged from 30 minutes to 45 minutes.

After the collection of the stating hypothesis questionnaire, Testing hypothesis questionnaire were distributed. Subjects were asked to test the different hypotheses proposed in the problems given. The time taken ranged from 30 minutes to 50 minutes.

SCORING THE INTELLIGENCE TEST

The scoring on Intelligence Test was done as directed by the manual carrying each item of raw score 1.

SCORING ON STATING HYPOTHESIS QUESTIONNAIRE

The different hypotheses proposed by the subjects were listed. The number of hypotheses proposed by each pupil was also scored. The total number of pupils emitting a particular hypothesis for all the hypotheses was found out and arranged all those hypotheses in the descending order

i.e. the highest coming first. All the pupils were arranged in the descending order meaning thereby that the boy or girl giving the smallest number of hypotheses coming at the top and the boy or girl giving the highest hypotheses coming at the bottom.

The number of errors in each hypothesis were determined and then co-efficient of fluctuations.

Scoring was done on the experiments proposed to test the hypotheses of each problem. The marks given for each hypothesis are as follows :

0 - Wrong answer
1 - Just describes
2 - Partly describes, and
3 - Complete right answer.

CHAPTER IV

ANALYSIS AND INTERPRETATION

CHAPTER IV

ANALYSIS AND INTERPRETATION

GRADE-ISE MEAN PERFORMANCE ON FOUR PROBLEMS IN STATING AND TESTING HYPOTHESIS

1. Stating Hypothesis on Problem No.1

TABLE I

Class	VIII	IX	X	XI
Mean	4.96	7.2	8.32	7.64
S.D.	1.54	1.58	1.31	3.01

The table indicates that except in grade XI the mean performance shows the increasing trend in grade. Regarding S.D. the class XI is the heterogenous of the four classes.

II. Stating Hypothesis on Problem No.2

TABLE II

Class	VIII	IX	X	XI
Mean	4.56	7.4	6.2	6.72
S.D.	1.22	0.91	1.91	1.65

On Problem No.2 the mean performance shows the increasing trend alternatively. However S.D. shows the homogenity in class IX and X.

III. Stating Hypothesis on Problem No.3

TABLE III

Class	VIII	IX	X	XI
Mean	5.88	6.96	6.2	6.96
S.D.	2.20	2.07	2.36	2.40

Regarding Problem No.3 the mean performance is same in class IX and X whereas class VIII has the lowest mean. Class XI is the heterogenous of the four classes regarding S.D.

IV. Testing hypothesis on problem No.4

TABLE IV

Class	VIII	IX	X	XI
Mean	3.64	6.32	6.44	6.36
S.D.	1.15	1.73	1.26	1.74

In this problem the mean performance is highest in class VIII and shows decrease in IX class again increasing in X and decreasing in XI. Regarding S.D. class XI is the heterogenous among all four classes.

V. Testing hypothesis on problem No.1

TABLE V

Class	VIII	IX	X	XI
Mean	3.6	4.64	4.32	4.6
S.D.	1.66	1.38	1.70	1.68

The table indicates the increasing trend in the mean performance alternatively. However class X is the heterogenous regarding S.D.

VI. Testing hypothesis on Problem No.2

TABLE VI

Class	VIII	IX	X	XI
Mean	5.92	6.84	6.12	6.96
S.D.	2.22	2.21	2.26	2.40

In this problem class XI show heterogenity in the mean performance whereas there is increasing trend alternatively in S.D.

VII. Testing Hypothesis on Problem No.3

TABLE VII

Class	VIII	IX	X	XI
Mean	5.88	6.96	6.2	6.96
S.D.	2.20	2.07	2.36	2.40

In this problem the mean performance of class IX and XI is the same whereas there is increasing trend in S.D. upto the class XI.

VIII. Testing Hypothesis on Problem No.4

TABLE VIII

Class	VIII	IX	X	XI
Mean	5.76	6.92	6.04	6.88
S.D.	2.10	2.1	2.26	2.40

In this problem there is increasing trend alternatively in the mean performance as well as S.D.

INTERPRETATION OF CORRELATION MATRIX

Using Product Moment Correlation Method it became possible to calculate correlations among four problems, the number of correlations being 6 in number ($\frac{4 \times 3}{2}$).

I. Stating Hypothesis

TABLE IX

	1	2	3	4
1.	1	.22*	.24*	.41**
2.		1	.28**	.46**
3.			1	.47**
4.				1

* Significant at .05 level

** Significant at .01 level

The table shows that all the correlations except two are significant at .01 level. The exception being in case of the correlation between Problem 1 and Problem 2 and Problem 1 and Problem 3 which is significant at .05 level. This finding gives reason expected because all the four problems attempt to measure the same variable i.e. ability to state hypothesis.

II. Testing Hypothesis

TABLE X

	1	2	3	4
1.	1	.56**	.96**	.94**
2.		1	.97**	.97**
3.			1	.87**
4.				1

* Significant at .05 level
** Significant at .01 level

The table shows that the correlation between different problems in testing hypothesis also have been found to be invariably significant. The co-efficient of correlation range from .56 to .97. It is evident from the above table that in most cases the relationship is nearly perfect. Except in only one case i.e. the relationship between Problem No.1 and Problem No.2, the coefficient of

correlation are much higher i.e. .87, .94, .96 and .97.

It seem, therefore, that so far as testing of hypothesis is concerned the hypotheses proposed to test on different problems in the study are highly interrelated. Success or failure on one is invariably followed by success and failure on others.

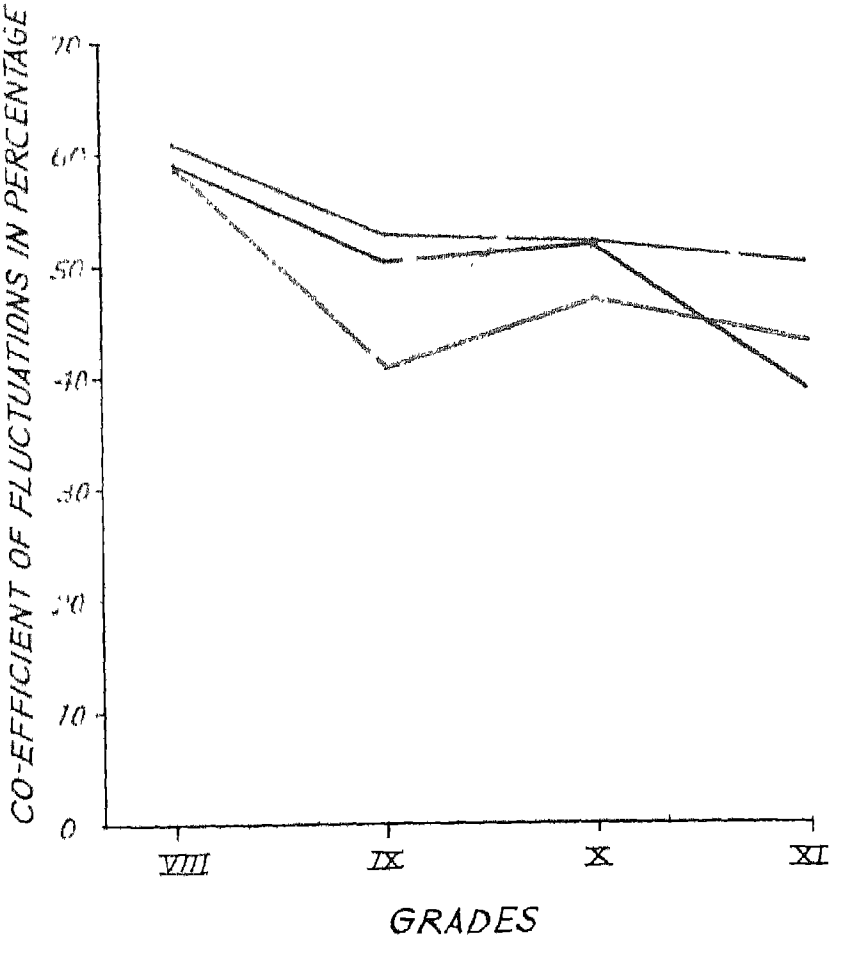
COEFFICIENT OF FLUCTUATIONS IN STATING HYPOTHESIS

TABLE XI

Problem No.	Coefficient of Fluctuations			
	Class VIII	Class IX	Class X	Class XI
1.	61.43%	53.22%	52.40%	50.4%
2.	58.78%	41.21%	50.96%	43.33%
3.	40.66%	42.5%	60.11%	47.6%
4.	59.13%	50.75%	52.43%	38.99%

As one of the side aims it was considered desirable, to determine the extent of fluctuations gradewise in stating hypothesis on all the four problems. It was, therefore, considered to compute the coefficient of fluctuations for all the four problems. It was, therefore, considered to compute the coefficients of fluctuations for all the four problems in respect of all pupils of grade VIII to grade XI

Graph showing Co-efficient of fluctuations in stating Hypotheses on different problems



REFERENCE

PROBLEM No. 1

PROBLEM No. 2

PROBLEM No. 3

PROBLEM No. 4

by using a technique as suggested by Guttman. It may be added that we have not computed the coefficient of fluctuations which show the extent to which the statement of a given hypothesis is not shared by a group of children belonging to that grade. The table above gives the coefficient of fluctuations for the various classes on the four problems chosen on the study. From the table, the coefficient of fluctuations for the problems 1, 2 and 4 show a decreasing trend with age.

It is, however, strange that this is not the case with problem 3 which deals with the flow of water through width tube. The reason for this can not be given because we do not know the past history of the students. But the coefficients of fluctuations in respect to this problem perhaps tends to show that the pupils are possibly evaluating hypothesis.

Contd.

PERFORMANCE SCORES AND 't' VALUES BETWEEN TOP AND BOTTOM GROUP IN STATING HYPOTHESIS, PLOTTING MANIPULATION AND ANALYSIS OF INTERPRETATION, USE AND GRAPH

TABLE XII

Mean, S.D. and Variance of bottom group in Stating Hypothesis

Problem	1	2	3	4	Total
Mean	4.8	4.72	5.28	3.68	18.28
S.D.	1.41	1.4	1.17	0.94	2.44
Variance	2.7	1.96	1.38	0.89	5.96

TABLE XIII

Mean, S.D. and Variance of Top Group in Stating Hypothesis

Problem	1	2	3	4	Total
Mean	8.8	7.29	9.72	7.28	33.28
S.D.	1.80	1.26	1.74	1.28	1.98
Variance	3.25	1.60	3.04	1.63	3.96

TABLE XIV

Mean, S.D. & Variance of Bottom Group in Testing Hypothesis

Problem	1	2	3	4	Total
Mean	4.8	4.72	5.28	3.68	18.28
S.D.	1.41	1.4	1.17	0.94	2.44
Variance	2.7	1.96	1.38	0.89	5.96

TABLE XV

Mean, S.D. & Variance of Top Group in Testing Hypothesis

Problem	1	2	3	4	Total
Mean	4.64	6.88	6.92	6.76	25.2
S.D.	1.70	2.52	2.53	2.49	9.20
Variance	2.90	6.36	6.41	6.19	84.67

TABLE XVI

Mean, S.D. & Variance of Bottom Group in Intelligence, Age and Grade

	Intelligence	Age	Grade
Mean	35.84	158.24	1.24
S.D.	3.61	11.15	0.83
Variance	13.05	124.52	0.69

TABLE XVII

Mean, S.D. & Variance of Top Group in Intelligence, Age and Grade

	Intelligence	Age	Grade
Mean	35.2	179.95	2.92
S.D.	4.79	12.99	0.90
Variance	22.91	168.62	0.83

Table XLIII

't' Values between Top Group and Bottom Group :

Intelli-gence	Age	Grade	Stating hypothesis					Testing hypothesis				
			Problem 1	Problem 2	Problem 3	Problem 4	Total	Problem 1	Problem 2	Problem 3	Problem 4	Total
0.53	6.33**	7.34**	8.33**	7.00**	10.82**	12.85**	24.19**	2.46*	1.83	1.91	1.90	2.00

* Significant at .05 level

** Significant at .01 level

From the above tables it can be said in short that age and grade rather than intelligence favoured the top group. When it comes to the stating of hypothesis, the top group beat the bottom group on its ability i.e. stating hypothesis both at .05 % and .01 % levels of confidence. When it comes to the testing of hypothesis, the 't' values decline as judged by their size. Only on the 1st problem the significance between the two groups reaches 0.05% level of confidence, the other 't' values on the other three problems are less than the expected values at the .05% level.

CHAPTER V

SUMMARY AND CONCLUSIONS

Jean Piaget has given a stage concept according to which intelligence develops in stages, with clear definable steps. According to him formation of hypotheses comes naturally to the adolescence pupils especially after the age of eleven. The present study was undertaken to test part of Piaget's ideas on formal stage.

PROBLEM STATED

The problem was stated as :

"A STUDY ON EXCLUSION OF VARIABLES DURING ADOLESCENCE"

PURPOSES OF THE STUDY

The purposes of the study were:

1. To determine the relationship between the scores on intelligence and the scores on exclusion of variables.

2. To determine the relationship between age, grade and the scores on exclusion of variables.

3. To point out the main educational implications based upon the findings of the study.

HYPOTHESES

The hypotheses formed for the study were :

1. There is no significant differences on the mean scores of intelligence test and the scores on exclusion of Variables between the top group and the bottom group.

2. There is no significant correlation between the grades and scores on Stating Hypotheses.

3. There is no significant correlation between the grades and scores on Testing Hypotheses.

JUSTIFICATION OF THE STUDY

The researcher has felt the necessity to carry out the present study influenced by the basic notions of Jean Piaget as the Education for understanding and problem solving is becoming the chief goal of Education anywhere in the world's educational system.

Institute of Educ

PLAN AND PROCEDURE

100 students of class VIII, Class IX, class X and class XI (25 from each class) of Demonstration Multi Purpose High School, Regional College of Education were taken as sample. The students are day scholars and of average socio-economic status belonging to urban areas. The age range of the students were 12+ to 17+.

DELIMITATION

The sample was drawn from only one school offering general science as the compulsory subject.

SELECTION OF TOOLS

The tools selected were :

1. Cattells' Culture Fair Intelligence Test (Scale II)
2. Stating Hypothesis Questionnaire.
3. Testing Hypothesis Questionnaire.

ADMINISTRATION & SCORING OF THE INTELLIGENCE TEST AND STATING & TESTING HYPOTHESES QUESTIONNAIRE

The administration of intelligence test and both the questionnaires was done in their respective classes one at a time. The time for intelligence test was given as mentioned in test manual and the time taken by students for both the hypotheses ranged from 30 minutes to 45 minutes.

The scoring on Intelligence test was done as directed by manual.

In stating hypotheses, the total number of pupils omitting a particular hypothesis for all was found out and arranged all those hypotheses in the descending order. All the pupils were arranged in the descending order meaning, the pupil giving the smallest number of hypotheses coming at the top and the pupil giving the highest hypotheses coming at the bottom. The number of error in each hypothesis were determined and then co-efficient of fluctuations.

The scores given to test the hypotheses of each problem are :

0 - Wrong answer
1 - Just describes
2 - Partly describes, and
3 - Complete right answer

MAIN FINDINGS AND CONCLUSIONS

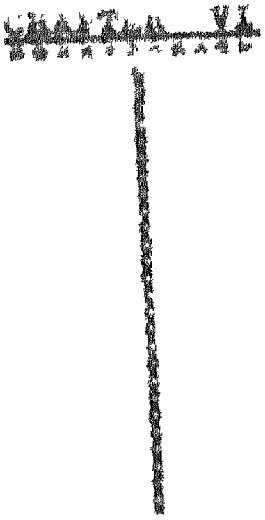
1. Very few fluctuations here and there in the mean performance of all the problems show the increasing trend in stating and testing hypotheses with grade.

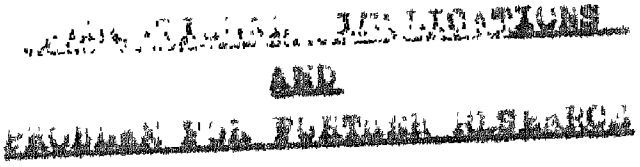
2. All the problems are strongly correlated with each other. It is so because they measure more or less the same intellectual structure.

3. Using the Guttman Technique as suggested by him in ascertaining the undimensionality thought, the same was used

to determine the coefficient of fluctuations in their thought processes. The values of which coefficient show that pupils show vast individual differences in abilities related to stating hypothesis.

4. Using the top 25% and bottom 25% groups it was seen that they differ significantly from each other in respect to the variables - age and grade. However, they did not differ on intelligence. The reason for this appears to be that intelligence test is used as one of the admission tool. Those who get below certain score are not offered admission.





CHAPTER VI

EDUCATIONAL IMPLICATIONS

Jean Piaget has frequently said that he is not at all interested in children, Psychology and Teacher Training. Being an Epistemologist by training, he did not work out the educational implications of his work. However, the influence of his half century's work is being felt at all levels of education. Professor Kraplus has developed 3 types of lessons namely Exploratory, Inventive and Discovery.

In the first lesson the children are asked to play with the material without any resorting to direct teaching.

In the second lesson children are expected to invent the concept. After having done this the children get abundant opportunities to apply his concept in as many as different situations. It is thus according to Piaget the

knowledge of children becomes functional in their learning. During the formal stage the children become quite autonomous in their intellectual behaviour.

In the present study, the children were found to possess the ability to state hypothesis. Their, this ability can be enhanced by studying the coefficient of fluctuations through the medium of hypothesis as shared by a group of children. In other words, individual hypothesis not shared can be pointed to or shown to those who have missed those hypotheses. The teacher may set the teaching learning situation in such a way that the children get into the habit of learning from each other.

In short, teacher should have some vague idea about the sequence of learning of the various learning processes underlined a group of facts that is concept. The maximum score for testing hypothesis is 33. The means for the four problems in respect of classes VIII, IX, X and XI are 19.04, 27.88, 27.16, and 27.68. These values show that it is only the class VIII children who are not in a position to test hypothesis, the percentage of doing so is $\frac{19}{33} \times 100$ (57.5%). In other classes majority of pupils are in a position to test hypothesis. This shows that their minds have become truly logical or experimental.

PROBLEM FOR FURTHER RESEARCH

In Science we come across the term concept. In Psychology Piaget and others have given us a similar term called scheme of Thought. This idea is very recent. It is, therefore, necessary to determine the psychological structure of any school subject through a series of schemes of Thought, which adequately sample it. One such scheme of thought included in study is the one on Exclusion of Variables during adolescence. It has yet to be mathematically fixed. Its growth has yet to be seen on different samples of students studying in different schools. Its relationship with outside variables is yet to be investigated. Then the role of teacher on the growth of this variable is yet to be known for all practical purposes. It is also yet to be known how many schemes of thought are really fundamental in the fields of Physics, Chemistry, Biology, General Science and other environmental Sciences etc. The researcher can choose any other problems and studied empirically. Then he can relate his results to the basic ideas of Jean Piaget which have been stated in logical terms.

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Name : _____

Age : _____ Sex : _____

School : _____

Date : _____ Class : _____

Study questionnaire (Individual)

Boys and girls! You come across many problems, in one form or the other, in your daily life. Just think! What do you do when you are faced with a problem? You start to think about it, do not you? You try to find a solution, or may be several solutions. I am going to propose to you four problems. What I want to know is how you react to these problems, how you think through it: how you arrive at a solution or solutions? Is it always possible to solve a problem completely? What do you think?

The main purpose is to know the extent of thought that you bring into while solving these four problems. I would like you to write down the various ideas that come to your mind while solving a problem. You can number your ideas. Anything you need which supports your thinking, is supposed to be available. Let me explain what I want from you by giving an example.

Problem 1

Example :

I am showing you an experiment. Have you a close look at the experimental set up and the diagram which I have drawn for you. A rod is coated with wax into which four pebbles are fixed. (Fig.1) You see these do not fall down why? because they are fixed into wax. If I heat one end of rod tell me what happens? Pebbles will fall one by one. Can you tell me why do they fall? Because wax

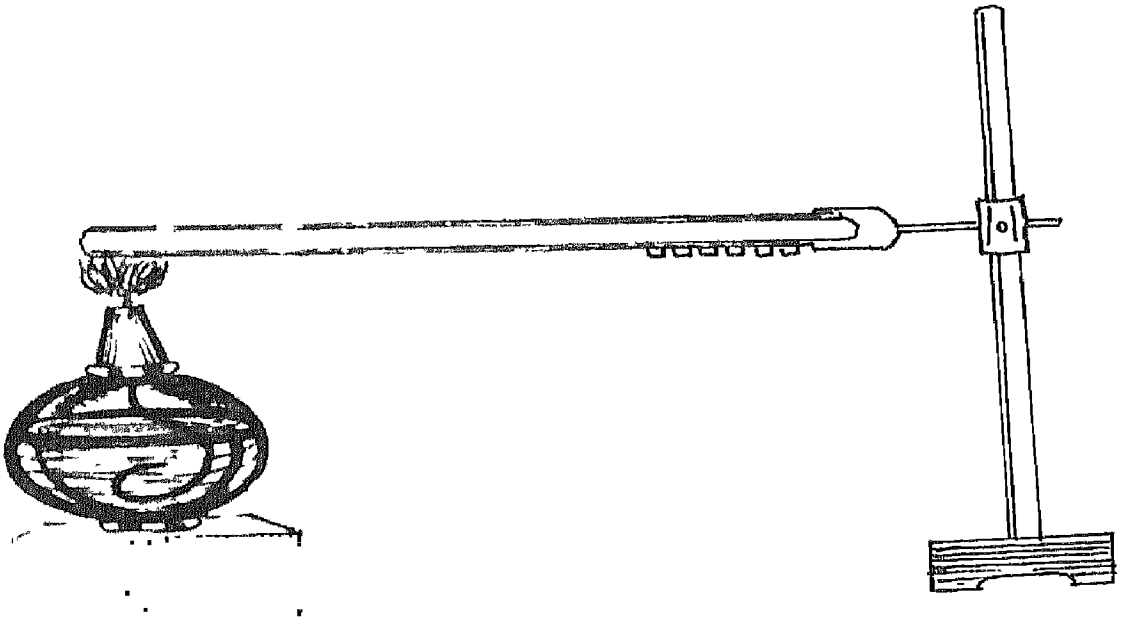

Fig.1

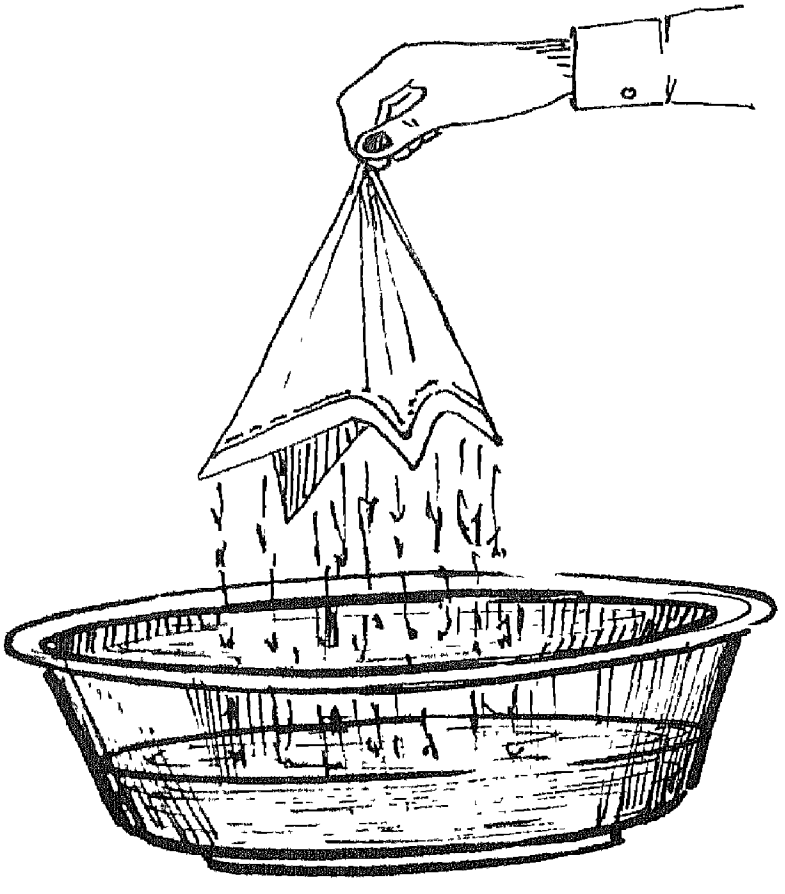

Fig.2

has melted. Our question is : What are the factors on which the dropping of various pebbles depends? One student of your age gave us the following answers :

1. It depends upon the source of heat.
2. The distance between source of heat and first pebble.
3. The nature of rod
4. Larger the distance between the pebble and source, slower the pebble will fall in relation to other pebbles.
5. The temperature of source.
6. Room temperature and many other factors.

Note : Please be brief in your writing. You can see the problem in any way you like and consider as many factors as you can think of.

The fall of any pebble depends upon the following factors :

1._____ 9._____
2._____ 10._____
3._____ 11._____
4._____ 12._____
5._____ 13._____
6._____ 14._____
7._____ 15._____
8._____ 16._____

In a similar manner solve the following three problems :

Problem 2

I am showing you a wet handkerchief. Name the factors on which drying up of the handkerchief depends. (Fig.2)

It depends upon the following factors :

1._____ 2._____
3._____ 4._____

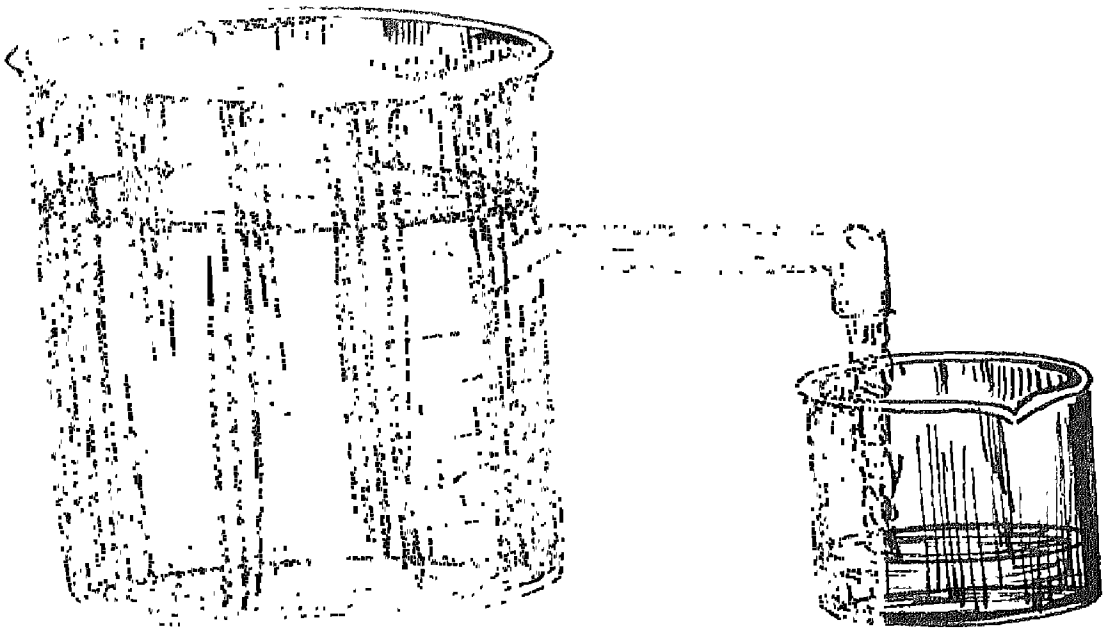

Fig. 3

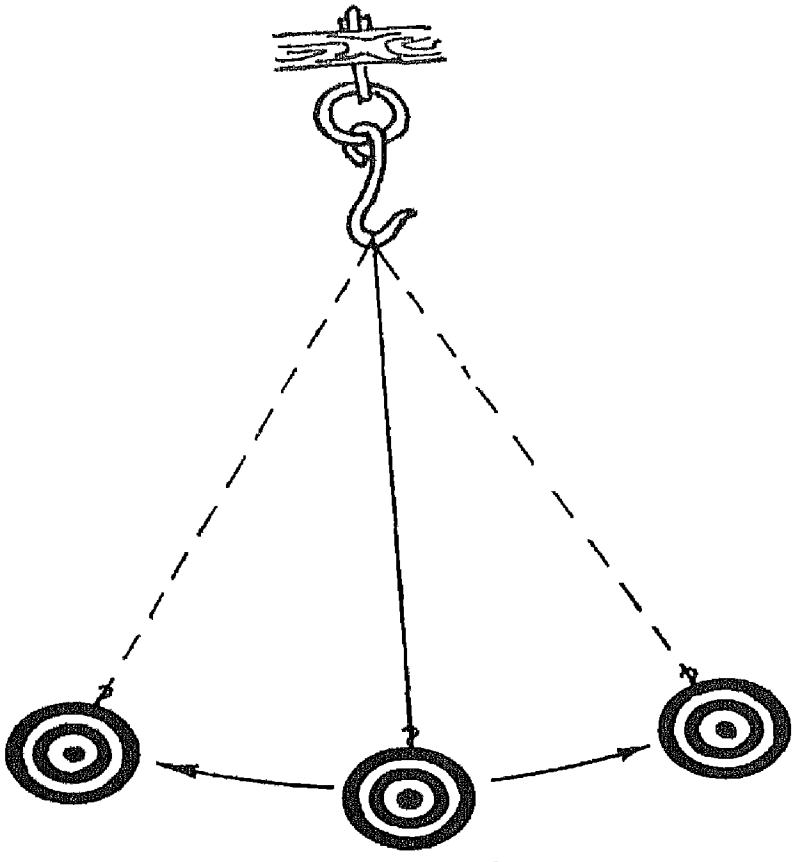

Fig. 4

5._____ 9._____

6._____ 10._____

7._____ 11._____

8._____ 12._____

Problem 3

Have a look at the experiment. (Fig.3) Water is flowing through tube and collecting in a small beaker. What are the factors upon which the quick filling up of water in half hour depends?

It depends upon the following factors :

1._____ 6._____

2._____ 7._____

3._____ 8._____

4._____ 9._____

5._____ 10._____

Problem 4

Here I am showing you a simple pendulum. (Fig.4) Its bob moves sideways on both sides of centre. This is called its amplitude. Note the various factors on which time for one oscillation depends. It depends upon the following factors:

1._____ 6._____

2._____ 7._____

3._____ 8._____

4._____ 9._____

5._____ 10._____

Name :_____

Date :_____ Sex : Male / Female

School_____

Age : _____ Class:_____

To Find The Mirotime Co-ordinates

Problem 1

You have mentioned many factors on which dropping of pebble depends. I am going to select the following three factors.

1. Nature of material of rod
2. Length of the rod
3. Thickness of rod

Let me discuss the first factor.

Nature of material of rod :
I will take two rods of different material say iron and al as of same length and thickness. I will fix pebbles on both at equal distances from one of their ends, and heat the other ends simultaneously. Next I will find out which of the pebbles on which of the rod falls first and which one falls last. Then I am going to make a judgement : if all the pebbles fall at the same time, it means that nature of materi l has no effect so far as dropping of pebbles is concerned. If they fall at different times then I will conclude that nature of material of rod is very important factors.

Similarly, through experiments I can also test the influence of other two factors : Now set an experiment to isolate the influence of :

(1) Thickness of the rod :

(2) Length of the rod :

I would like you to discuss other three problems in a similar manner.

Problem 2

The drying up of handkerchief depends upon the following factors :

1. Length of handkerchief.
2. Thickness of handkerchief, and
3. Nature of material.

You suggest experiments which will isolate these factors :

1. Length of handkerchief :

2. Thickness of handkerchief :

3. Nature of material :

Problem 2

Amount of water collected in beaker in a given time depends upon :

1. Length of tube
2. Size of the hole
3. Level of water in the larger beaker

Suggest experiments which will isolate these factors :

1. Length of tube

2. Size of hole

3. Level of water in larger beaker

Problem 4

Time taken in one oscillation by the pendulum depends upon :

1. Length of the pendulum
2. Volume of bob
3. Movement of bob

Suggest experiments which will isolate these factors :

1. Length of the pendulum

2. Volume of bob

3. Weight of bob